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One of the major impediments to the adoption of needed curricular reform in the high school is the restrictive, manually constructed schedule. To help solve this scheduling problem, the computer based Stanford School Scheduling System (SSSS) was developed. Experience with the SSSS demonstrates its feasibility and shows that administrators can be freed from the burden of scheduling without losing the opportunity to make vital educational scheduling decisions. Costs of approximately $1 per student are comparable to costs of manually constructing schedules. Furthermore, a computer can investigate in a few seconds the millions of possible combinations of teachers, students, rooms, and limits of time, thus making it possible to satisfy a high percentage of student schedule requests. Computer scheduling also increases the range of professional decisions possible. Since flexible scheduling is necessary for obtaining the freedom to experiment with a wide range of curriculum alternatives, restrictions imposed by manual scheduling techniques must be removed. The computer can provide maximum freedom to choose a schedule reflecting the abilities and interests of students as well as the special qualifications of teachers. (TT)

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FLEXIBLE SCHEDULING: A REALITY

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FLEXIBLE SCHEDULING: A REALITY

The Key

The need for curricular reform in the high school is unquestioned; demand for change is in crescendo. One might reasonably ask, where is the "bottleneck?" There may be a number of answers to this question, but surely a major impediment is the restrictive, manually constructed schedule. It would be interesting to know how many worthy ideas and innovations have foundered on the simple reality, "It can't be scheduled."

As high schools become larger and more comprehensive, manual scheduling becomes increasingly restrictive. A key to the scheduling problem, obviously is a requisite for needed curricular improvement. Mindful of education's technical lag, and with a considerable financial assist from the Ford Foundation, in the spring of 1960 the Stanford computer-based High School Flexible Scheduling and Curriculum Study was launched.[1]

Professor R.V. Oakford, an industrial engineer and computer scientist, developed the programming and systems necessary to construct a generalized computer scheduling procedure which could satisfy the widest possible range of schedule design. This process is known as the Stanford School Scheduling System (SSSS). By the melding of diverse talents, the study was able to implement the educational ideas of Bush and Allen through the technology of Oakford's computer scheduling system. Success has meant that manual scheduling, the nemesis of both principal and curriculum, is no longer the chief restraint to curriculum experimentation.

As an illustration of possible dimensions of scheduling reform, the flexible scheduling project has developed scheduling procedures to accommodate the New Design for High School Education developed at Stanford by Robert N. Bush and Dwight W. Allen.[2] The high school envisioned in the "New Design" is a complex model, but it can be unraveled, sequenced, and partitioned.

A computer-generated, flexible, high school schedule was a reality. Field testing was needed. Many school administrators agreed with the basic assumption that there is a better way to organize the time element of the curriculum. To proceed past the verbal level, however, required a great deal of courage, foresight, and community support. Four schools with these qualities, and outstanding leadership, were selected to launch the first flexible, computer generated, high school schedules, using the Stanford School Scheduling System.[3]

During the 1962-63 school year, the faculty and administration of each of these four schools built and refined unique structures for each course. Extensive use of large-group lectures, team-teaching, small-group discussions, long periods of laboratory time, and the opportunity for independent study were incorporated.

It should be noted exactly what is meant by a computer-generated schedule. The school provides the necessary input data. There must be a list of course offerings and the structure for each course. Within each course, different structures may be requested -- large-group lectures, laboratory periods of varying lengths, small-group discussions, and independent work in a resource center are examples. Teachers must be assigned to teach each of the sections of each part of each course. Room lists and the sections they can accommodate are the third item of input. Finally, students' program requests must be provided. All of these lists can be exact in their specifications, or alternatives may be specified. The Stanford School Scheduling System then processes this input data and determines who will teach what, when, where, and to whom. The master schedule is generated, and students are assigned to it.

It would be misleading, indeed, to infer that the generalization of those first four pilot schedules provided no problems. Many educational decisions needed to be made at each stage of the scheduling process. Refinements were continually made in procedures designed to analy correct, and regenerate the basic schedules. School administrators and faculties were frustrated by delays close to absolute, final deadlines. Perhaps the best global evaluation of

the first field trials is the fact that twenty-two schools have been scheduled for the 1964-65 school year. Faculties and administrations are enthusiastic; new ideas for course structure an new uses for student and teacher time are abundant. The four pilot schools welcome visitors and the opportunity to discuss, with interested school people, their problems and successes.

It is evident that the requests for scheduling assistance will exceed the capacity of the present facilities and system. Effort is now being addressed to refinement. As refinements improve the basic system, the schedule of a high school can become, truly, a function of the curriculum.

Opportunity

If the question were asked, "What reason is there for the present 'egg-crate' allocation of time in a high school schedule?", the answer would rest heavily on tradition. Outdated assumptions about the use of school time have been challenged by the "New Design." Conceptualizing the curriculum as a function of space has opened the door to new, imaginative course structures. Possibilities range from the present thirty students for sixty minutes, five days each week, to virtually any time and size variations of a basic structural module of five or more students and fifteen or more minutes. Nearly any desired teaching configuration can be provided. To best illustrate this design potential, consider this example:

FLEXIBILITY

A tenth grade English course has an enrollment of 347 students. Time allocated for this course is fifteen modules per week, which is comparable to the traditional provision (i.e. 15 x 20 minutes = 300 minutes; 5 x 60 minutes = 300 minutes). A team of three teachers is teaching this course. At this point, however, our English course becomes quite atypical. Thr teachers, as a team , designed the course that they are teaching; this is a major and important departure. We will refer to this point again.

How did the team elect to use the fifteen minute time modules? They concluded that a part of their instruction could be provided for 347 students in one group as effectively as for thirty, with a considerable conservation of time and energy. Further, adequate facilities (auditorium) for large-group instruction were available. After due consideration of the material to be presented, a large-group meeting (347 students) was designed for two modules (forty minutes) once each week.

The team wanted to provide a weekly classroom opportunity for their students to write Moreover, they wished to make optimal use of the part-time, para-professional aide assigned to their team. For this phase of instruction, a design that would allow a reasonable number of students to write, be tested, or clarify material, was needed. The group size selected was sixty students, which allowed the use of double rooms (sixty-five seats). Further, this situation could be handled easily by one teacher or proctored by an aide. The time required was a more difficult decision; how long does it take to write well? How long should a test be? Many factors were important in this choice. With considerable deliberation, the writing laboratory was set at four modules (eighty minutes) once each week.

In the opinion of the team, the heart of the instructional process for this course would be the opportunity for each student to ask questions, answer questions of their classmates, discuss new concepts, present material from their own study, and receive personal teacher guidance toward the goals of the course. From the limited experimental evidence available, it would seem that these kinds of activities could best be served in a small group (ten to fifteen students). Moreover, the team wanted a period of time that would adequately provide for thorough discussion, interaction, and closure. Intuitively, they felt that the small groups should meet for at least one hour (three modules). Dictated by the importance of the small group function, they requested two meetings each week for this phase, a total of six modules (two hours).

In addition to these three phases of our English course (i.e., large-group, writing lab, small-group), there remain three modules of independent study (sixty minutes). This time is not scheduled. This is an important factor in the development of the educational potential of a student to allow for the exercise of his own volition in pursuing his academic responsibilities. Our observations to date lead us to speculate that this may prove to be, at least for many students, the most important phase of the learning process.

After the careful, professional deliberations of three experienced English teachers, a design for instruction has been formed. What, specifically, has been provided for each student and each teacher? Each individual will be exposed to new information by three teachers. The teachers make best use of their individual competencies; they would have, therefore, three weeks to prepare for each major presentation. Once each week, every student would have the opportunity to write for more than an hour, under supervision, where he will receive immediate feedback and assistance as needed. The two hours of small group meeting will provide close, personal interaction between both teacher and student and the student and other students.

Our example is not the only way, certainly, to teach tenth-grade English. It is, however, in the opinion of the three most important people involved -- the teachers who designed the structure -- the way in which they can teach most effectively. More important, variations in the structure of English courses permit a new functional level of self-evaluation of the course structure. From this evaluation, new and more appropriate patterns for teachin will emerge.

The three teachers say that they are working harder but on a higher professional plane and with more satisfaction. There is also some additional anxiety, understandably, due to adjusting to a new method of teaching. But more important is their strong personal commitment to "their program" and, consequently, a higher motivational drive toward the teaching task.

There is evidence, from our brief observation, that as scheduling per se becomes a less critical factor, the concern for curricular innovation increases. One need be in one of the pilot flexibly scheduled schools only a short time to realize that the educational atmosphere is different. Teachers seem to have more time to teach; students have more time to learn.

It is rewarding to observe four members of a social studies team at 10:30 in the morning in a teacher's office, vigorously discussing the content, sequence, and subsequent small-group follow-up for an ensuing series of large group lectures. This meeting was made possible by virtue of a scheduled team planning meeting. Evidently, lecturing for thirty-five minutes to 300 students carries more professional impact than the daily meeting with thirty students. Further, it is difficult to imagine this vigorous and productive discussion at 4 to 5 P.M. after a full day in the classroom.

It seems reasonable to assume that some activities in the learning process can be best accomplished by the student independently. Independent study is surely a function of motivation but might it not also be a function of time, place, and facilities? In the flexible scheduled schools, these factors are evidenced in several interesting ways. Libraries are burgeoning with students actively engaged in academic pursuit. Non-fiction book usage has increased many fold. Areas designated for relaxation and snacks are, surprisingly sparsely attended. The great majority of students, evidently, when provided with an opportunity for individual initiative, want to make the most of their school experience.

At Marshall High School in Portland, Oregon, in addition to an increase in library usage, seven rooms have been equipped with study aids and supplemental materials. Each of these resource centers is presided over by a teaching aide who supervises special materials and gives limited assistance with student problems. These centers receive heavy use and high acceptance by both teachers and students. Often teachers are available in resource centers to give remedial and special assistance.

Another possible innovation in the use of independent study time is the designation of open laboratories. This is an arrangement whereby students, with their teacher's approval, may use laboratory facilities as their time permits. One art course meets formally only for one large-group meeting and one short, instructional laboratory period each week; the remaining time is scheduled by the student himself as independent study. In this way the emphasis of instruction is focused on performance. The student must accomplish well-defined learning tasks with established levels of quality. Individual differences in the time it takes to meet these performance criteria are automatically provided for. Judging from our initial observations, the increased emphasis on performance may well be one of the most important innovations in the organization of high school education.

Of particular interest to school administrators is the abrupt decline in disciplinary problems, especially those relating to classroom behavior. This is a phenomenon observed in all pilot schools. One might tentatively conclude that most high school students are capable of assuming a great deal more academic and social responsibility than has been expected previously. In such a dynamic school environment, freedom from scheduling restrictions may assume even greater importance.

Experience with the Stanford School Scheduling System demonstrates that a computer-generated schedule is feasible. Professional educators can be freed from the burden of scheduling without, however, losing the opportunity to make vital educational scheduling decisions.

Present test runs with traditional school schedules indicate that the dollar costs of computer scheduling are comparable with present costs, i.e., approximately $1.00 per student. More complex schedules will cost somewhat more.

A second consideration is the efficient use of other scheduling resources. School schedules are the result of the simultaneous availability of three basic elements: (1) teachers, (2) students, and (3) rooms, within well-defined limits of time. The nearly infinite number of combinations

of these factors far exceed the capacities of the most astute educator. A sophisticated computer, however, has a memory capacity that will investigate millions of possible combinations within a few seconds. Consequently, the availability of teachers, rooms, and student requests for each class can be determined at each stage of schedule development. Thus, a high percentage of student requests can be satisfied.

There are, however, important things that a computer cannot do. A computer is an intricate box of switches that is controlled completely by a logically designed program. The computer and the programs of control are logical and systematic procedures; there is no mistique -- no magic. The computer cannot create needed rooms, additional teachers, or expand time available for a program. The limits of reality have not been altered, but the ability to manipulate the factors within these limits has been greatly enhanced.

The Stanford School Scheduling System provides an opportunity for human control at each scheduling phase. This control factor is enhanced by the availability of a complete analysis of all scheduling data at the time of each decision. Obviously, control of the school's schedule has not been lost to a machine; in fact, the range of professional decisions has been increased.

The major motivation for the Stanford computer-based Flexible Scheduling Project was to obtain the freedom to experiment with a wide range of curriculum alternatives. If, as educators, we wish to have the schedule reflect the abilities and interests of students and the planned teaching activities of the staff, then a more flexible scheduling technique is imperative. It is generally agreed that manually constructed schedules are limited to a fairly narrow range of alternatives and that the computer is a requisite for scheduling reform. Thus, at any point on the continuum of curriculum and time structure, from traditional to flexible, the computer can provide more alternatives and the freedom to choose.

Conclusion

The basic logic needed to solve the complext problem of constructing a completely generalizable scheduling procedure has been formulated. The multi-program system is being used. Refinements, however, are needed. Every school, like the social structure within it, has a way of being unique. Each new school scheduled, therefore, presents new problems. Close cooperation between technical programmers and the school will assure continual refinement, adaptation, and expansion of this powerful tool.

The Stanford System is adaptable to a broad range of schedule design. The original pilot schools and the subsequent twenty-five would attest to this. Communication and transportation has made the vast power of the modern computer feasible. The question is: Will schoolmen have the courage and foresight to use the computer now that it is available?

Suddenly a half century of manual school scheduling restrictions have been laid aside. Will school leaders resist the temptation to cling to the comfortable, traditional ways? Can the venturesome educator avoid the hazards of creating a new orthodoxy? These are questions that the computer era will soon answer. Hopefully, new patterns for teaching, new uses of student time, and more effective use of facilities will emerge from the creative efforts of educators. With many more students, with much more material to teach, and with a limited number of qualified teachers, the need for educational innovation has never been more acute. The power of the modern computer stands ready to assist.

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1. Staff of the Stanford High School Flexible Scheduling and Curriculum Study includes: Co-directors Dwight W. Allen, Robert N. Bush, and Robert V. Oakford, and the following Research Assistants: Jerry Becker, Lynne Chatterton, Jimmie C. Fortune, Donald De Lay, Thomas Quirk, James E. Smith, W. Verne Stevenson, and James W. Wilson.
2. A New Design for High School Education: Assuming a Flexible Schedule, Robert N. Bush and Dwight W. Allen. McGraw-Hill, 1964.
3. Homestead H.S. P.O. Box F, Sunnyvale, Calif. Lincoln H.S. 6844 Alexandra Pl. Stockton, Calif., Marshall H.S., 3905 S.E. 91st Ave., Portland 6, Oregon, Virgin Valley H.S., Mesquite, Nevada.